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IX.—*Contributions to Structural Botany.* By W. Hughes Willshire, M.D., M.B.S., Lecturer on Botany at Charing Cross Hospital.

1.—Specimens of *Ulva calophylla*, Spreng., having lately been transmitted to the Botanical Society of London, I have had an opportunity of fully examining this curious alga, and it appears to me worthy of some remark, both as regards its structure and its relative affinities. Under the microscope several forms of the plant may be seen, and which to me appear to be permanent, at least whatever form perfects its quaternary granules I think should be looked upon as a perfect plant: this may either exist as a cylindrical cellular filament continuing of the same diameter throughout its whole length, except close to its fixed extremity, where it becomes slightly attenuated and rounded, and is more or less conical at the opposed one; it undergoes no alteration or change of form, but two rows of quaternate granules are produced in the cellular cylinder;—it may be observed as a flattened strap or band of a breadth equal to four or five diameters of the filament or even more, becoming considerably attenuated towards its fixed extremity, and is more or less constricted at distant intervals, a membranous band being seen at the points of constriction; —lastly, it may be seen as a very broad flattened frond, rather suddenly constricted into a delicate cylindrical stipes. With respect to these different conditions, I would observe, that the first or cylindrical one is not necessarily to be regarded as an imperfect condition of the others, or as one that must necessarily, at an after period of the life of the plant, pass or become metamorphosed into them. Except in the earliest stages of the life of the plant, in whatever condition of age or form it may be observed, it will be found that the margins of the band or strap, and the circumference of the cylinder, are brightly transparent; that the flattened frond is traversed longitudinally by transparent lines, varying in number according to the breadth of the strap, and between which are placed green-

coloured granules; these latter, however, varying in number, colour and size according to the age and figure of the plant. Whatever form the plant may assume in advanced periods of growth, in its earliest which I have been able to detect, it exists as a very delicate cylindrical filament (this is quite distinct however from the form before alluded to) divided at intervals by transverse septa, and presenting therefore a cellular structure. These cells I shall denominate primary cells; in some of the cells a little point or nucleus is seen, the rest of the cell being bright and transparent, whilst the other cells are filled with a thin green-coloured matter. This point or nucleus I regard as the first stage of the green granular sporular matter, which in the other cells is distinctly seen as having arrived at its second stage. The further development of the plant appears to ensue from self-division of the primary cellule, such division taking place both in a longitudinal and transverse direction; the granular matter being divided with the cells, and the law being that each primary cell shall form four cells, and each of these four cells four granular masses, so that sixteen granular masses are the result. Thus the primary cell becomes divided transversely, and hence two granular masses are formed; a single row only of granules however running down the length of the frond. In the further development these secondary cells become divided longitudinally, so that four tertiary cells result from the primary one, in each of which is contained a granular mass which separates into two portions. From the wall of separation formed in the longitudinal division being stronger and broader than that of the transverse, and from its withstanding more perfectly the pressure of the internal coloured matter, a transparent band or line is observed to run down the frond between the inner surfaces of the tertiary cells.

Whilst self-division of the cells has been going on, the frond gradually increases in breadth until the tertiary division becomes complete, at which it ceases, all further growth being terminal, if the plant is to continue to exist in the cylindrical or linear form; the green matter however undergoes a change to which we shall allude directly. It will be remarked, that in the form we have just alluded to, although we have two rows of cells running down the frond, only one series of primary cellules has been developed, and upon this fact appears to depend the preservation of the cylindrical figure; if more series than one are developed, their lateral pressure against the walls of the cylinder causes the latter to become extended laterally, and hence ensues the flattened riband shape or strap-like form; and according to the number of series of primary

cells, so is the breadth of the frond. The same process of division takes place with each series of primary cellules, so that supposing four series to have been developed, there will be seen eight rows of tertiary cells. In those plants assuming the flattened and laterally extended form, the markings of the different series are very and beautifully evident, they being divided from each other by bright longitudinal bands, and which are much more evident than the transparent lines separating the tertiary cells from each other; in fact, the latter are almost disregarded by attention being attracted so strongly to the former, which I would therefore denominate the *serial bands*, the others the *cellular lines*. Very often the cellular lines are completely obliterated as *transparent* ones by the pressure of the granules in the opposed cells, a *dark* line resulting from the close approximation of the edges of the granules. It is the *serial bands* to which specific distinction has been attached. When the series of primary cellules increase suddenly in number, a transverse cellular band is seen running across the frond where its increase of breadth commences; and even in fronds preserving the same serial conditions throughout their length, these transverse bands are to be seen at places where there is evident constriction. The tertiary division of the cells being complete, the green granular matter contained in each of the four cells resulting from this division becomes separated into four portions, each portion or mass apparently being enveloped by a cellular covering, thus resembling somewhat four agglomerated granules of pollen. As far as I have been able to discern, the quatenary division of the granular matter does not result from a further division of the tertiary cell, but from a plastic power exclusively its own. When the granules are observed moving about after their separation from the frond, they are sometimes noticed adhering in fours, as they do in the cells; at other times they separate very soon from each other, each little one moving about by itself, and marked with a dark central spot. The general colour of the granules is certainly that of a bright green; but others, and which are the largest, and generally those which have only undergone a binary division, are of a much deeper and more olive-green hue. It is very evident that the plant is quite destitute of colour, independent of that which it receives from the granular or sporidial matter; to me, also, that the youngest condition of the plant is cylindrical and cellular, in fact *confervoid*; and also that this condition may remain, and yet the plant perfect quaternary granules. In the metamorphosis of it to the flattened form, the interserial spaces and margins become thick and much developed, presenting quite a homogeneous appearance, the frond often

having constrictions at distant intervals, and which appear to me to be merely forms of very elongated, flattened, metamorphosed, confervoid cells. In the flat fronds it is rather difficult to discern the walls of the cells without attentive observation; but with care, and a due regard being paid to the transmission of light from the mirror of the microscope, an eye accustomed to the appearances vegetable structures present will soon detect them. The termination of the frond is rounded, or more or less sharply conical, the length variable from a line to nearly half an inch, the breadth depending upon the number of serial cells primarily developed, and the whole plant often twisted, waved or curled.

In the second volume of Sir J. W. Hooker's 'Flora' our present plant is arranged under the genus *Ulva*, with the remark appended, that "although arranged by Captain Carmichael among the *Bangiæ*, it is but justice to his memory to state that he remarked in a note that this plant and *Bangia velutina* of Lyngbye were more nearly allied to the *Ulvæ* than to the gelatinous *Bangiæ* of the second division."

Mr. Harvey, in his late work, also arranges it in the same genus (*Ulva*). To me it does not appear to have its natural location in this genus; it is true that the plant is wanting in some of the characteristics of the *satisfactorily* determined *Bangiæ*, as stated by Captain Carmichael, and also that the flattened forms of it do simulate to a considerable extent the characters of the genus *Ulva*. I look upon it as certainly *confervoid* in its earliest state, and always so in certain of its perfect and adult conditions; but that it also becomes metamorphosed into a form which closely approximates to that of the family *Ulvaceæ*. The genus *Bangia* has already been supposed a group of the *Confervæ* by some botanists, and which has certainly a connexion with our present plant, but yet not sufficient to admit of its reception. It appears, under all considerations, by no means unwarrantable that this plant shall form the type of a new family intermediate between *Confervæ* and *Ulvaceæ*, a family osculant of these two, connecting the family *Confervæ* to *Ulvaceæ* by the genus *Bangia* however rather than by that of *Ulva*.

2.—Two or three years ago it was stated by Dutrochet, that in the nodi of *Viscum album* no true woody matter existed; that the vascular connexion of the internodial spaces was therefore broken up, or was only maintained by a layer of *cellular tissue* or *pith*: this doctrine was admitted, and *Viscum* was supposed to form another illustration of what have been called *articulated stems*. Some time after Decaisne published a small work on the woody structure of this plant, in which he contradicted the statement of Dutrochet, and

maintained that the vascular or woody portions of the internodial spaces were continuous, and the state of articulation was solely dependent upon the non-continuity of the vessels of the bark. Dutrochet again averred before the French Academy that his views were right. Here I believe the matter has rested. I have taken some pains to satisfy myself which of these theories is correct. I have examined portions of the plant both young and old, and at all portions of the nodal places, and I fully concur with Decaisne in stating that the true woody and vascular structure of *Viscum* is perfectly continuous through the nodi; that there is no transverse and separating layer of cellular tissue or pith in this portion of the plant, but that the connexion of the inner layers of the *bark* is broken up at the nodi. *Viscum album* has not an articulated stem, in the proper sense of the word then. The vascular structure of *Viscum album* is by no means so entirely composed of those peculiarly marked and rather elongated cells as is generally drawn and stated. Kieser's representations are often copied, but they only represent a part of the vascular apparatus; no doubt a great portion of the woody matter is composed of cells quite different from those met with in the wood of Exogens; but if the young wood or first-formed bundles be examined, plenty of very long annular ducts—and (to me) spiral ducts, with the fibre unrollable, however, as far as I have been able to detect—will be found. I may also remark, that the long pleurenchymatous cells surrounding the first-formed vascular bundles are carried along with the latter to the centre of the plant, around the pith of which they may be found,—a circumstance somewhat analogous to that stated by Decaisne to take place in *Menispermaceæ*.

3.—There are very few plants, in the anatomy of whose pleurenchymatous and vascular structure a stronger support for *some* of the views of Schleiden on the origin of *spiral structure*, &c. can, I think, be seen, than in *Tilia europæa*. The anatomy of the tissues of this plant appears to me to prove that primary membrane is homogeneous and structureless, but that the secondary formations of tissue ensuing within cells composed of such primary membrane are in their form and nature *fibrous*, and in their direction *spiral*. Out of such secondary structure the origin of all tissue presenting a fibrous appearance, and the least tendency to a spiral direction in any period of its growth or development, is to be looked for. In this plant, as also in many others of the families *Asclepiadaceæ* and *Apocyneæ*, it appears evident, that in the development of the primary fibrous layers, two fibres having opposite directions are formed; but

whether such is always the law of evolution, and taking place in every plant, is, I think, not sufficiently proved. In *Tilia* especially this law, however, can be seen operating, in the formation of the spiral fibres on the wall of the cells of the pleurenchyma. That the *continuous* spiral development is the base of all forms of annular reticulated and dotted vessels I think certain, and the various metamorphoses which arise from such base are to be sought for in the peculiar after-growth of the primary structureless membrane upon which the secondary fibrous layers were originally deposited. Very often, as may be seen in *Tilia*, this membrane becomes entirely absorbed, the coils of the secondary spire brought close together; and this happening during the development of the fibres, the spiral continuity ceases to exist; the molecules from which the fibres are formed hence pass into a series of more or less broad, flat, and continuous bands; and vessels formed of such fibres, totally destitute of primary membrane, are to be found in the plant just referred to. In fact, much of the tissue of *Tilia* represents many stages and states of evolution of the secondary fibrous layers in connexion with peculiar after-growth of the primary structure upon which they have been deposited. I have observed *compound* spiral vessels in the petiole of *Tilia pubescens*.

4.—On the under surface of the leaf of *Adelia nereifolia* may be found a very beautiful and peculiar form of scale; it consists of two circular layers of cellular membrane, the one layer of much smaller diameter than the other, puckered and plaited, and of a saucer-shaped form; it is fixed by its centre, which apparently is connected with a *gland* having coloured contents. From this form of scale, through that met with on *Eleagnus conferta*, I think transitional states may be seen, to the stellate hairs of many of the *Euphorbiaceæ* and *Malvaceæ*; in fact, upon the peculiar adhesions taking place between the cells depends the appearance of the stellate hair or the scale of *Adelia* and *Eleagnus*. The occurrence both of stellate hairs and this form of scale in *Euphorbiaceæ*, shows the structural differences between the two not to be great in their origin.

[To be continued.]

X.—*On the Separation of the Pomegranate as a distinct Natural Order from* Myrtaceæ. By Robert Wight, M.D., F.L.S., &c.*

The most eminent botanists of the present day being divided in opinion as to the propriety or otherwise of separating the

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